SWINE FEEDING TRIALS *in* HAWAII

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ABSTRACT

Swine production in Hawaii is based largely on garbage feeding. Other feeds and byproducts can be used as available. The profitableness of their use depends on the cost of such other feeds and byproducts and the price of resulting pork. Results of experiments with various feeds and the feed cost of producing pork with different combination of feeds are summarized in this bulletin.

Raw sweetpotatoes supplemented only with protein supplements were unsatisfactory. In the cooked form, sweetpotatoes gave good results even for pigs at the weanling weight.

Because of the presence of prussic acid in the bark of some cassava varieties, all trials here reported were based on cassava meal resulting after the roots had been sliced, dried, and shredded or ground. A mixture of 85 percent cassava meal plus 15 percent soybean oil meal was worth 95 percent as much as barley as a hog feed.

All taro feeding trials were based on cooked taro, or on cooked taro scraps from poi factories. When supplemented only with protein supplements, results were unsatisfactory. When used to substitute for one-fourth of a standard control mixture, the cooked taro on the cooked, wet basis was worth 36 percent as much as the control ration. On the dry basis its value would be increased two to two and one-half times.

The value of algaroba beans ranged between 43 and 86 percent that of the control ration (largely barley). The higher value resulted when the beans were first kiln dried and ground into a meal.

Raw sugar at times costs about the same as imported concentrates. The inclusion of some sugar resulted in better gains and a reduced quantity of the concentrate mixture needed to produce a pound of gain.

Cane molasses in amounts up to 20 percent of the concentrate ration for both weanling and fattening pigs was worth about as much as the barley which it replaced.

Pineapple sirup proved somewhat superior to cane molasses particularly when constituting over 40 percent of the concentrate ration. Being higher in ash content, cane molasses was more laxative at the higher levels.

Pineapple bran containing about 20 percent fiber is not an ideal feed for swine and results in reduced gains in proportion to the quantity included in the ration. However, because of the much lower price, the inclusion of pineapple bran usually results in lower cost gains. Older pigs can utilize this byproduct to better advantage than pigs that have just been weaned.

Fish meal and tankage proved to be of about equal value when used as protein supplements.

Fresh papayas were worth about one-fourth as much as the standard control ration when constituting one-fourth to one-third of the ration.

Avocados, when substituted for 25 to 30 percent of the control ration, were worth 23 to 46 percent as much as the control ration.

Bananas at the same level of substitution had an average value of 38 percent of the control ration they replaced.

Cull tomatoes fed alone had no value, but when fed with a control ration to the extent of 70 to 98 percent of the ration (fresh basis) had a value ranging from 12 to 4 percent of the control ration, the higher value being obtained with the lower rate of substitution.

Garbage from military sources had a value 40 percent that of a good grain ration, based on the quantity required to produce a pound of gain. In these experiments garbage alone proved an excellent feed for fattening hogs, 9 to 13 pounds producing 1 pound of gain.

Addition of molasses to garbage increased the quantity of the mixture required to produce a pound of gain, especially when as much as 30 percent cane molasses was added.

Garbage proved satisfactory for weanling pigs and brood sows. Under the conditions of these experiments comparing garbage, concentrate rations, and combinations of garbage and concentrate rations, no significant differences in size of litter, birthweight of pigs, or mortality could be demonstrated for the different methods of feeding.

CONTENTS

AUTHOR'S NOTE: The cooperation of staff members and students who assumed leadership, assisted, or carried out the experiments which make up this bulletin is acknowledged here, and their names are included in the sections reporting the work in which they participated.

INTRODUCTION

Swine production in Hawaii is largely based on garbage feeding. During the war years the supplies of garbage were greatly increased and the number of swine in Hawaii was more than doubled. Now the quantity of garbage is again reduced to approximately that of the prewar period and a material reduction in the swine population has occurred.

Other feeds are available in Hawaii and their value has been tested in experiments at the University of Hawaii Agricultural Experiment Station. These include imported cereals and various byproducts as well as locally produced feeds and byproducts.

One Bulletin—No. 69, *Cane Molasses as a Supplement to Fattening Rations for Swine*—and two Technical Bulletins—No. 3, *Cane Molasses for Pigs from Weaning to a Weight of Seventy Pounds,* and No. 7, *Garbage as a Feed for Swine*—have been published. Results of many other trials with various crops and byproducts are scattered through the annual and biennial reports of the Hawaii Station. It seems advisable, at this time when garbage supplies are inadequate, to assemble these data in bulletin form for more ready reference. For completeness, a condensation of the data already published in bulletin form will be included. For greater details on these subjects, the reader is referred to the published bulletins.

ORGANIZATION OF DATA

All check or control rations used are designated by the letters A to L. All experimental rations are identified by numbers from 1 to 70. The same control ration was used in comparison with more than one experimental ration which accounts for the smaller number of the former.

For each crop or byproduct with which feeding trials were conducted, there are shown first the details of the rations used followed by a table showing condensed results of the feeding tests in which the rations are referred to by letter or number. This is followed by brief comments when these seem necessary.

GREEN FEEDS

Green supplementary feeds, usually panicum grass or honohono, were fed with practically all rations, usually at the rate of about 1 pound per pig per day. However, weighbacks were not always made, and when made, did not seem reliable due to fouling of the green feed with fecal matter, etc. For this reason the green feed consumed was omitted from the tabulation showing weights, gains, feed per pound of gain, etc. Failure to show these data should not be assumed to mean that green feed was not provided.

FEED COST OF GAINS IN LIVEWEIGHT

The costs of producing a pound of gain are often omitted in studies of this kind because feed prices are constantly fluctuating and many feeds, such as cull fruits, have no established price. Local costs or values of feeds can always be applied to the quantities of feed required to make a pound of gain in order to get current feed costs of pork production or, the value of resulting pork can be used to evaluate the feed or byproduct used to produce such gains.

However, many hog raisers would like to have figures available on the probable costs of producing pork with feeds at different prices without the necessity of calculating them from the data presented. To meet this need, the approximate costs for 1936, 1940, 1944, and 1948, respectively, of the basic feed ingredients used in swine rations are shown in table 1. These figures were used in computing the cost of a pound of gain in the various trials and combinations of feeds used. It is realized that some of these costs are mere estimates, for some feeds that are useful in swine feeding have no established price at present.

TABLE 1. Approximate average prices of feeds.

FEED	1936		1940		1944		1948	
	per ton	per pound	per ton	per pound	per ton	per pound	per ton	per pound
Algaroba meal*	$ 25.00	$.0125	$ 30.00	$.0150	$ 40.00	$.0200	$ 50.00	$.0250
Avocados, cull*	8.00	.0040	8.00	.0040	20.00	.0100	30.00	.0150
Bananas, cull*	8.00	.0040	8.00	.0040	20.00	.0100	30.00	.0150
Barley, rolled	26.00	.0130	32.00	.0160	80.00	.0400	120.00	.0600
Bonemeal, steamed	49.00	.0245	49.00	.0245	55.00	.0275	60.00	.0300
Cassava meal*	30.00	.0150	36.00	.0180	44.00	.0222	50.00	.0250
Cassava–molasses meal*	28.00	.0140	34.00	.0170	42.00	.0210	48.00	.0240
Corn, cracked	40.00	.0200	42.00	.0210	82.00	.0410	137.00	.0685
Coconut oil meal	36.00	.0180	40.00	.0200	60.00	.0300	95.00	.0475
Fish meal	49.00	.0245	49.00	.0245	111.00	.0555	160.00	.0800
Garbage, military*†	10.00	.0050	10.00	.0050	8.00	.0040	40.00	.0200
Linseed oil meal	40.00	.0200	37.00	.0185	72.00	.0360	112.00	.0560
Molasses, cane	5.00	.0025	5.00	.0025	6.00	.0030	25.00	.0125
Meat and bonemeal	52.00	.0260	50.00	.0250	58.00	.0290	102.00	.0510
Papayas, cull*	5.00	.0025	5.00	.0025	12.00	.0060	20.00	.0100
Pineapple bran	19.00	.0095	19.00	.0095	22.00	.0110	35.00	.0175
Pineapple sirup*	6.00	.0030	7.00	.0035	8.00	.0040	30.00	.0150
Rice, bran*	26.00	.0130	25.00	.0125	50.00	.0250	64.00	.0320
Rice, rough*	50.00	.0250	52.00	.0260	80.00	.0400	130.00	.0650
Rock phosphate	30.00	.0150	32.00	.0160	40.00	.0200	50.00	.0250
Salt	30.00	.0150	30.00	.0150	60.00	.0300	60.00	.0300
Soybean oil meal	42.00	.0210	44.00	.0220	78.00	.0390	130.00	.0650
Soybeans, roasted*	130.00	.0650	140.00	.0700	150.00	.0750	150.00	.0750
Sugar, raw	65.00	.0325	56.00	.0280	75.00	.0375	113.00	.0565
Sweetpotatoes, raw*	20.00	.0100	38.00	.0190	60.00	.0300	40.00	.0200
Tankage	52.00	.0260	50.00	.0250	70.00	.0350	130.00	.0650
Taro scraps, cooked*	10.00	.0050	16.00	.0080	20.00	.0100	30.00	.0150
Taro, cooked*	20.00	.0100	38.00	.0190	60.00	.0300	40.00	.0200
Tomatoes, cull*	3.00	.0015	3.00	.0015	5.00	.0025	12.00	.0060
Wheat middlings	38.00	.0190	36.00	.0180	60.00	.0300	92.00	.0046

* Assumed price—not often available and rarely at regular feed dealers.

† Cooking garbage adds to the cost, but since definite data are not available, the same value is used in these computations for cooked and uncooked garbage.

CARBONACEOUS CROPS AND BYPRODUCTS LOCALLY PRODUCED

SWEETPOTATOES

Sweetpotatoes can be readily grown in Hawaii and even if prices are too high to justify using them as livestock feed, some cull potatoes which have no other value are usually included.

The ration used in the different trials will be briefly outlined and results in tabular form are given in table 3. Approximately 1 pound of green feed per pig per day was fed with all rations.

These trials were not extensive enough to justify final conclusions, but they do suggest that raw sweetpotatoes supplemented only with fish meal as a protein source are unsatisfactory, especially for younger pigs (trials I and II). Results were materially better when a limited amount of a concentrate ration was fed along with the sweetpotatoes (trial III). By far the best results were secured when the sweetpotatoes were cooked prior to feeding (trial IV). In the cooked form, supplemented as they were in experimental ration 3, sweetpotatoes seemed entirely satisfactory, even for pigs at the weanling weight.

CASSAVA

Because of the presence of prussic acid in the bark of some cassava varieties, all trials here reported were based on meal made by slicing, drying, and shredding or grinding the cassava roots. Green feed was fed in all cases, but records on quantities consumed are not complete.

These trials indicate that cassava meal is suitable as a feed for swine and has a value approaching that of barley.

In trial I, where the pigs were fed free choice from self feeders, only about 21 percent cassava meal was selected. In trial II the rations were the same except that 57.5 percent cassava meal plus 10.5 percent soybean oil meal in the experimental ration replaced 68 percent barley in the control ration. Based on resulting gains and feed consumption, calculations show that in this trial the mixture of 84.5 percent cassava meal and 15.5 percent soybean oil meal was worth 94.8 percent as much as the barley which it replaced in control ration A. Results will be found on page 7.

TARO AND TARO PRODUCTS

Experiments have been conducted on feeding cooked taro scraps secured at the poi factories as well as feeding the taro corm. The experiments and ration will be briefly outlined and results in tabular form for all the trials will be found in tables 6 and 7 on page 8.

TABLE 2. Composition of rations used in sweetpotato trials I–IV.*

INGREDIENT	TRIAL I		TRIAL II†	TRIAL IV	
	Control ration A	Experimental ration 1	Experimental ration 2‡	Control ration B	Experimental ration 3§
	percent	*percent*	*pounds*	*percent*	*percent*
Rolled barley	68	..	..	68	..
Cane molasses	20	..	..	20	20
Fish meal	8	free choice	8	10	13
Linseed oil meal	2	..	..	..	..
Bonemeal	1	..	1	1	..
Sweetpotatoes	..	free choice	free choice	..	53
Pineapple bran	..	..	..	..	13
Salt	1	..	1	1	1

* In trial III approximately 2 pounds per pig per day of control ration A was fed and experimental ration 2 was fed free choice. No control lot was used.

† The control ration used in trial II was the same as that used in trial I.

‡ The 8 pounds of fish meal, 1 pound of bonemeal, and 1 pound of salt were mixed and fed free choice.

§ In experimental ration 3 all of the ingredients were cooked.

TABLE 3. Results of sweetpotato feeding trials.

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT	AVERAGE DAILY GAIN	FEED CONSUMED PER POUND OF GAIN				CONCENTRATE FEED COST PER POUND OF GAIN			
						Control ration	Raw sweetpotatoes	Fish meal	Cooked sweetpotato ration	1936	1940	1944	1948
			days	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*				
I	Control A	3	43	139.3	1.34	5.25	....	...	...	$.0635	$.0740	$.1759	$.2698
	Experiment 1	3	43	139.8	0.71	...	16.08	0.96	...	.1840	.3289	.5351	.3987
II	Control A	3	42	76.6	1.56	5.03	....	...	...	.0609	.0709	.1685	.2585
	Experiment 2	3	42	76.0	0.28	...	40.40	1.71	...	.4443	.8079	1.2975	.9304
III	Control A and Experiment 2	4	56	111.1	1.00	2.06	8.00	0.67	...	.1207	.1968	.3425	.3139
IV	Control B	3	80	38.2	0.81	3.34*	....	...	...	.0407	.0474	.1132	.1733
	Experiment 3	3	80	38.8	0.82	...	....	...	5.49	.0736	.0829	.1394	.1433

* Feed intake limited so that this lot did not make more rapid gain than the lot fed the cooked sweetpotato ration.

TABLE 4. Composition of rations used in cassava feeding trials I and II.

Trial I

INGREDIENT	EXPERIMENTAL RATION 4	EXPERIMENTAL RATION 5	EXPERIMENTAL RATION 6
	percent	*percent*	*percent*
Rolled barley	17.0	14.0	18.0
Cracked corn	28.0	32.0	41.0
Cassava meal	21.0	...	...
Cassava–molasses meal	...	22.0	...
Pineapple bran	...	...	9.0
Wheat middlings	20.0	19.0	19.0
Tankage	14.0	13.0	13.0

Trial II

INGREDIENT	CONTROL RATION A	EXPERIMENTAL RATION 7
	percent	*percent*
Rolled barley	68	...
Cane molasses	20	20
Fish meal	8	8
Linseed oil meal	2	2
Bonemeal	1	1
Salt	1	1
Cassava meal	..	57.5
Soybean oil meal	..	10.5

TABLE 5. Results of cassava meal feeding trials.

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT	AVERAGE DAILY GAIN	FEED PER POUND OF GAIN	CONCENTRATE FEED COST PER POUND OF GAIN			
							1936	1940	1944	1948
			days	*pounds*	*pounds*	*pounds*				
I	Experiment 4	7	84	45.0	1.11	3.47	$.0638	$.0677	$.1173	$.1836
	Experiment 5	7	84	45.0	1.03	3.79	.0694	.0735	.1273	.2001
	Experiment 6	7	84	45.0	0.98	3.53	.0650	.0671	.1243	.2033
II	Control A	3	33	77.9	1.92	4.34	.0525	.0612	.1454	.2231
	Experiment 7	3	33	81.3	1.71	4.59	.0647	.0730	.1060	.1460

TABLE 6. Composition of rations used in taro feeding trials I–IV.

INGREDIENTS	TRIAL I		TRIAL II*	TRIAL III		TRIAL IV‡
	Control ration C	Experimental ration 8	Experimental ration 9	Control ration B	Experimental ration 10†	Control ration D
	percent	*proportion*	*proportion*	*percent*	*percent*	*percent*
Barley	88	..	..	68	..	64
Tankage	8	..	..	..	..	..
Linseed oil meal	2	..	..	..	..	..
Salt	1	..	..	1	1	1
Bonemeal	1	..	..	1	1	1
Cane molasses	..	..	..	20	..	20
Fish meal	..	..	..	10	49	7
Soybean oil meal	..	..	..	..	49	7
Cooked taro scrap	..	1/3	1/4	..	..	..
Whole cooked taro	..	..	..	..	free choice	..
Control ration C	..	2/3	3/4	..	..	..

* The control lot in trial II was fed ration C.
† In experimental ration 10 both the whole cooked taro and the mixture of fish meal, soybean oil meal, bonemeal, and salt were fed free choice.
‡ Experimental ration 10 was also used in trial IV.

TABLE 7. Results of taro feeding trials .

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	POUNDS CONSUMED PER POUND OF GAIN				CONCENTRATE FEED COST PER POUND OF GAIN			
						Concentrate mixture	Cooked taro scraps	Whole cooked taro	Protein supplement	1936	1940	1944	1948
			days	*pounds*	*pounds*								
I*	Control C	5	105	53.3	1.22	4.41	...	....	...	$.0631	$.0741	$.1733	$.2633
	Experiment 8	5	105	53.6	1.12	4.15	2.07	....	...	.0697	.0863	.1838	.2788
II†	Control C	6	56	81.6	1.48	4.56	...	....	...	.0652	.0766	.1792	.2722
	Experiment 9	6	56	82.5	1.76	4.07	1.36	....	...	.0650	.0793	.1736	.2634
III‡	Control B	5	100	55.7	1.24	6.08	...	....	...	.0742	.0863	.2061	.3156
	Experiment 10	5	100	56.0	1.00	...	...	11.64	0.87	.1361	.2412	.3901	.2960
IV§	Control D	9	65	87.1	1.38	4.58	...	....	...	.0568	.0660	.1530	.2363
	Experiment 10	9	65	84.1	1.09	...	...	19.11	1.04	.2147	.3871	.6220	.4577

* By Masao Koga (Senior student) and L. A. Henke.
† By L. A. Henke and G. W. H. Goo.
‡ By L. A. Henke, S. H. Work, and Shigeru Tsubota (Senior student).
§ By S. H. Work, L. A. Henke, and Charles Maruyama.

In all of the taro trials cooked taro (or cooked taro scraps from poi factories) were used. In trial I, where taro was used to substitute for one-third of the control ration, the cooked taro was worth 12.6 percent as much as the control ration; in trial II, where taro was used to substitute for one-fourth of the control ration, the cooked taro was worth 36.0 percent as much as the control ration. Since the cooked taro contained only 39 percent dry matter, its value on the dry-matter basis would be about two and one-half times the percentages shown above.

When cooked taro was fed with only a protein supplement (both fed free choice) as was done in trials III and IV, results were unsatisfactory and somewhat similar to those secured when sweetpotatoes were fed with only a protein supplement.

ALGAROBA BEANS

Algaroba trees are widely distributed over the islands and the pods are generally utilized as livestock feed. Several trials designed to evaluate these pods as feed for swine are reported below. The details of the rations are given in table 8 and results in table 9.

In trial I the experimental ration 11 (largely kiln-dried algaroba meal) was worth about 86 percent as much as the control ration (largely barley). In trial II, in which the rations were the same except that barley in one was substituted for by algaroba beans (sun-dried, chopped) in the other ration, algaroba beans were worth only 43 percent as much as barley. These trials suggest that kiln-dried, ground algaroba bean meal is definitely superior to air-dried, chopped beans.

In these trials pigs were carried to the market weight in all cases, which accounts for the longer feeding period where the algaroba meal or beans were fed.

RAW SUGAR

There have been times when raw sugar prices were so low that the cost of nutrients in sugar was about the same as in cereal grains. A trial was conducted in which 5 and 10 percent of sugar was substituted for like amounts of barley. The details of the rations and results are given in tables 10 and 11 on page 11.

There was more than normal variation in the gains made by individual pigs in the same lot on the same feed which somewhat reduces the significance of the average results. However, the results of this one trial were rather favorable to the inclusion of some sugar in the ration; the economy of this will depend on the relative cost of sugar and other feeds.

TABLE 8. Composition of the control and experimental rations used in algaroba bean feeding trials I and II.

INGREDIENTS	TRIAL I		TRIAL II	
	Control ration E	Experimental ration 11	Control ration D	Experimental ration 12
	percent	*percent*	*percent*	*percent*
Barley	68	...	64	..
Cane molasses	20	14.1	20	20
Fish meal	5	7.0	7	7
Bonemeal	1	0.7	1	1
Salt	1	0.7	1	1
Soybean oil meal	5	7.0	7	7
Algaroba meal (kiln-dried)	..	70.5	..	..
Algaroba beans (sun-dried, chopped)	..	...	..	64

TABLE 9. Results of algaroba bean feeding trials.

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	POUNDS CONCENTRATE FEED CONSUMED PER POUND OF GAIN	CONCENTRATE FEED COST PER POUND OF GAIN			
							1936	1940	1944	1948
			days	*pounds*	*pounds*					
I*	Control E	5	79	68.0	1.59	4.82	$.0578	$.0680	$.1595	$.2463
	Experiment 11	5	100	60.6	1.31	5.62	.0708	.0815	.1208	.1686
II†	Control D	6	63	102.3	1.44	4.99	.0619	.0719	.1667	.2575
	Experiment 12	6	148	108.9	0.59	11.58	.1401	.1586	.2385	.3381

* By S. H. Work.
† By S. H. Work and Charles Maruyama.

TABLE 10. Composition of the control and experimental rations used in raw sugar feeding trial I.

INGREDIENT	CONTROL RATION C	EXPERIMENTAL RATION 13	EXPERIMENTAL RATION 14
	percent	*percent*	*percent*
Barley	88	83	78
Tankage	8	8	8
Linseed oil meal	2	2	2
Salt	1	1	1
Bonemeal	1	1	1
Raw sugar	..	5	10

TABLE 11. Results of raw sugar feeding trials.

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	POUNDS CONCENTRATE FEED CONSUMED PER POUND OF GAIN	CONCENTRATE FEED COST PER POUND OF GAIN			
							1936	1940	1944	1948
			days	*pounds*	*pounds*					
	Control C	6	84	44.3	0.90	5.31	$.0759	$.0892	$.2087	$.3170
I*	Experiment 13	6	84	44.3	1.08	4.82	.0737	.0839	.1889	.2868
	Experiment 14	6	84	45.3	1.14	3.83	.0624	.0689	.1494	.2275

* By Martin N. Lum (Senior student) and L. A. Henke.

CANE MOLASSES

For Fattening Pigs: Many trials on the feeding of cane molasses to swine have been conducted by the Hawaii Station. Bulletin 69 (see Introduction, page 3) covers, in detail, the work done to 1933. To make for completeness, the work reported in Bulletin 69 is briefly condensed here along with reports of other later trials. The rations fed are shown below and results of trials in condensed tabular form are given on page 14.

TABLE 12. Composition of control and experimental rations used in cane molasses feeding trials I–IV for fattening pigs.

INGREDIENTS	CONTROL RATION F	EXPERIMENTAL RATION 15	EXPERIMENTAL RATION 16
	percent	*percent*	*percent*
Barley	88	78	68
Cane molasses	..	10	20
Tankage	8	8	8
Linseed oil meal	2	2	2
Salt	1	1	1
Bonemeal	1	1	1

Experiments I to IV inclusive were all similar and were based on substituting 10 and 20 percent of cane molasses for barley in rations otherwise the same. The results show that when fed to fattening pigs having an initial weight ranging from 50 to 100 pounds in amounts up to 20 percent of the concentrate ration, the cane molasses was worth about as much as the barley which it replaced, resulting in a material economy in the cost of fattening swine.

For Weanling Pigs: A series of experiments was conducted to answer the question of whether cane molasses is suitable for pigs at the weanling age. Cane molasses was included in the rations at the rate of 0, 10, 20, 30, and 40 percent. Results in detail are published in a technical bulletin of the Hawaii Station.[1] For completeness, a brief summary of these trials is presented below.

These trials indicate quite conclusively that pigs from the time of weaning until they reach a weight of 60 or 70 pounds can utilize cane molasses efficiently up to 20 percent of the ration. With levels of 30 and 40 percent in the rations, the rate of gain and efficiency of feed utilization decreased markedly. The pigs receiving these amounts of molasses had diarrhea which was quite severe when 40 percent molasses was included in the ration.

[1] WILLETT, E. L., WORK, S. H., HENKE, L. A., and MARUYAMA, C. CANE MOLASSES FOR PIGS FROM WEANING TO A WEIGHT OF SEVENTY POUNDS. Hawaii Agr. Expt. Sta. Tech. Bul. 3, 1946.

TABLE 13. Composition of the control and experimental rations used in cane molasses feeding trials I–XIII with weanling pigs.

INGREDIENT	TRIALS I–VI		TRIALS VII AND VIII		
	Control ration G	Experimental ration 17	Control ration H	Experimental ration 18	Experimental ration 19
	percent	*percent*	*percent*	*percent*	*percent*
Rolled barley	48	48	44.5	48	37
Raw sugar	10	..	10.0	..	...
Cane molasses	...	10	...	10	20
Wheat middlings	20	20	20.0	20	20
Tankage	15	15	...	..	...
Soybean oil meal.....	5	5	9.5	6	7
Salt	1	1	1.0	1	1
Bonemeal	1	1	...	..	...
Meat- and bonemeal..	...	..	15.0	15	15

INGREDIENT	TRIALS IX–XI			TRIALS XII AND XIII*	
	Control ration I	Experimental ration 20	Experimental ration 21	Experimental ration 22	Experimental ration 23
	percent	*percent*	*percent*	*percent*	*percent*
Rolled Barley	60.5	64	53	42	31.5
Raw sugar	10.0	..	...	..	...
Cane molasses	...	10	20	30	40.0
Meat- and bonemeal..	19.0	19	19	19	18.5
Soybean oil meal.....	9.5	6	7	8	9.0
Salt	1.0	1	1	1	1.0

* Control ration I was also used in these trials.

PINEAPPLE SIRUP

Trial I: Pineapple sirup is a concentrate of pineapple juice after the removal of citric acid. In order to determine the feeding value of this sirup, a cooperative experiment was conducted in which the Hawaiian Pineapple Company, Ltd., furnished the pigs, feed, and labor. Pineapple sirup and cane molasses were compared at different levels of intake.[2] The percentage of pineapple sirup and cane molasses was increased in each ration after the pigs reached approximately 50 to 100 pounds in weight. As this was done, protein and energy requirements were equalized by adjusting other feeds in each ration. The trial lasted 77 days. Ten pigs were used in each lot. Free access to green feed was provided. Rations used are given in table 16 on page 17.

[2] The experiment was conducted in Hahione Valley, Oahu, by S. H. Work and L. A. Henke of the Experiment Station and W. A. Cleghorn of Hawaiian Pineapple Co., Ltd.

TABLE 14. Results of molasses feeding trials for fattening pigs.

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	POUNDS CONCENTRATE FEED CONSUMED PER POUND OF GAIN	CONCENTRATE FEED COST PER POUND OF GAIN			
							1936	1940	1944	1948
			days	*pounds*	*pounds*					
I	Control F	6	70	70.3	1.43	4.99	$.0714	$.0838	$.1961	$.2979
	Experiment 15	6	70	70.5	1.16	5.02	.0668	.0778	.1787	.2761
	Experiment 16	6	70	70.2	0.92	5.65	.0689	.0797	.1802	.2836
II	Control F	4	70	103.1	1.50	4.69	.0671	.0788	.1843	.2800
	Experiment 15	4	70	100.6	1.64	4.23	.0563	.0656	.1506	.2326
III*	Control F	5	126	48.8	1.03	4.33	.0619	.0727	.1702	.2585
	Experiment 15	5	126	49.2	1.12	3.88	.0516	.0601	.1381	.2134
IV*	Control F	5	76	81.5	1.36	4.54	.0649	.0763	.1784	.2710
	Experiment 15	5	76	79.8	1.44	4.40	.0585	.0682	.1566	.2420
	Experiment 16	5	76	81.0	1.45	4.34	.0529	.0612	.1384	.2179

* By L. A. Henke and G. W. H. Goo.

TABLE 15. Results of molasses feeding trials with weanling pigs.

TRIAL	RATION	TOTAL NUMBER OF PIGS	AVERAGE LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	POUNDS CONCENTRATE FEED REQUIRED PER POUND OF GAIN	CONCENTRATE FEED COST PER POUND OF GAIN			
							1936	1940	1944	1948
			days	*pounds*	*pounds*					
I–VI*	Control G	24	61	31.8	0.82	4.67	$.0869	$.0901	$.1714	$.2671
	Experiment 17 ...	24	61	30.7	0.74	5.00	.0780	.0840	.1665	.2640
VII–VIII	Control H	7	42	31.1	0.91	3.27	.0618	.0638	.1174	.1821
	Experiment 18 ...	7	42	30.6	0.91	3.27	.0510	.0546	.1063	.1671
	Experiment 19 ...	7	42	30.3	1.00	3.37	.0492	.0522	.0971	.1564
IX–XI	Control I	9	42	31.7	0.88	2.90	.0528	.0565	.1087	.1685
	Experiment 20 ...	9	42	32.5	0.86	3.26	.0486	.0544	.1108	.1744
	Experiment 21 ...	9	42	31.7	0.80	3.34	.0464	.0514	.1012	.1630
XII–XIII	Control I	6	42	31.4	0.76	2.88	.0524	.0562	.1080	.1673
	Experiment 22 ...	6	42	31.6	0.52	3.54	.0460	.0499	.0942	.1561
	Experiment 23 ...	6	42	31.1	0.39	4.31	.0513	.0552	.0991	.1702

* Some trouble was experienced with necrotic enteritis during these trials resulting in unsatisfactory gains and feed utilization.

The pigs in the three lots fed cane molasses averaged 1.10 pounds daily gain; those fed pineapple sirup averaged 1.27 pounds daily gain. Hence, average daily gains were 15.3 percent higher when pineapple sirup was used in the rations.

Based on feed consumed to make a pound of gain, the cane molasses rations were worth 92 percent as much as the pineapple sirup rations at the 10–20 percent level, 91 percent at the 20–40 percent level, and 85 percent at the 20–50 percent level.

It is apparent that cane molasses and pineapple sirup can be used to replace barley up to 40 to 50 percent of the ration for older pigs, but that at higher concentrations pineapple sirup becomes increasingly more effective than cane molasses, probably because cane molasses is higher in ash content and thus more laxative.

Trial II[3]: In a second experiment pineapple sirup was increased to 80 percent of the ration during part of the feeding period. The pineapple sirup ration and the control rations used follow. Green feed was supplied free choice.

Control ration E	*percent*	*Experimental ration 30*	*percent*
Barley	68	Pineapple sirup	80
Cane molasses	20	Protein supplement	20
Fish meal	5	Supplement consisting of:	
Soybean oil meal	5	Soybean oil meal	49
Salt	1	Fish meal	49
Bonemeal	1	Salt	1
		Bonemeal	1

Twenty pigs averaging 64 pounds initial weight were placed in two lots of 10 each. Lot I was fed experimental ration 30 the first 7 weeks, and the control ration E the last 7 weeks. Pigs in lot II followed the reverse procedure. Condensed results are presented in table 17.

The pigs made fair gains at the 64-pound weight on this largely liquid diet (ration 30) and very satisfactory gains at the 122-pound weight after having been fed a control ration to that weight. The results of this trial suggest that it seems more desirable to start the pigs on a reasonably good ration (as was done with lot II) and after they reach the 100- to 125-pound weight, change them to the pineapple sirup ration.

As used in this trial based on feed consumed to make a pound of gain, the pineapple sirup ration 30 was worth 78 percent as much as the control ration E during the first 7 weeks. Comparisons on this basis for the second 7-week period are hardly justified since the pigs no longer had the same initial weight.

[3] By S. H. Work, L. A. Henke, and Charles Maruyama.

TABLE 16. Percentage composition of rations, results, and costs for pineapple sirup feeding trial I.

	RATION 24		RATION 25		RATION 26		RATION 27		RATION 28		RATION 29	
	to 80 lbs.	after 100 lbs.	to 80 lbs.	after 100 lbs.	to 80 lbs.	after 100 lbs.	to 80 lbs.	after 100 lbs.	to 80 lbs.	after 100 lbs.	to 80 lbs.	after 100 lbs.
Feed												
Cane molasses	10	20	..	..	20	40	..	..	20	50	..	..
Pineapple sirup	..	..	10	20	..	..	20	40	..	..	20	50
Pineapple bran	15	25	15	25	15	25	15	25	15	25	15	25
Barley	53	37	53	37	43	16	43	16	43	6	43	6
Fish meal	10	8	10	8	10	8.5	10	8.5	10	8.5	10	8.5
Soybean oil meal	10	8	10	8	10	8.5	10	8.5	10	8.5	10	8.5
Bonemeal	1	1	1	1	1	1	1	1	1	1	1	1
Salt	1	1	1	1	1	1	1	1	1	1	1	1
Average initial weight (lbs.)	62.3		62.2		63.3		62.3		62.3		62.0	
Average daily gain (lbs.)	1.13		1.24		1.12		1.29		1.05		1.27	
Feed consumed per pound of gain (lbs.)	5.05		4.64		5.35		4.85		5.97		5.06	
Approximate* concentrate feed cost per pound of gain:												
1936	$.0613		$.0569		$.0556		$.0513		$.0577		$.0497	
1940	.0681		.0633		.0598		.0559		.0604		.0534	
1944	.1415		.1308		.1157		.1066		.1125		.0976	
1948	.2205		.2047		.1895		.1761		.1900		.1666	

* Assuming that feeds fed prior to 80 to 100 pounds of weight constituted one-fourth, and after that weight three-fourths of total feed consumed.

TABLE 17. Results and feed costs for pineapple sirup feeding trial II.

	PERIOD I—7 WEEKS		PERIOD II—7 WEEKS	
	Lot I ration 30	Lot II ration E	Lot I ration E	Lot II ration 30
	pounds	*pounds*	*pounds*	*pounds*
Average initial weight	64.0	64.0	106.0	122.0
Average daily gain	0.87	1.18	1.47	1.89
Feed required per pound gain.	5.13	4.02	4.50	6.23
Concentrate feed cost per lb. gain				
1936	$.0354	$.0482	$.0540	$.0430
1940	.0380	.0567	.0634	.0461
1944	.0646	.1331	.1489	.0785
1948	.1349	.2054	.2299	.1638

PINEAPPLE BRAN

In the canning of pineapples the outer hull is removed and this material when dried is known as pineapple bran. It has proved to be a satisfactory feed for cattle and work animals, but has been less used for swine feeding. In early trials of pineapple bran feeding for swine, this feed was supplied free choice along with barley, corn, middlings, tankage, etc., and it was found that under these conditions swine did not select more than 5 to 9 percent of pineapple bran. Following this the pineapple bran was mixed with other feeds prior to feeding. Details of rations and results are given in tables 18 and 19.

Comments on Pineapple Bran Feeding Trials: Trial I showed that including 50 percent pineapple bran in the ration materially reduced the rate of daily gains, but on the basis of feed required per pound of gain the pineapple bran ration with wheat middlings was 95 percent, and the pineapple bran ration with rice bran was 89 percent as effective as the control ration. These pigs averaged about 80 pounds liveweight when the trial was started and pineapple bran is more suitable for pigs of this or even heavier weight.

Trial II was a comparison between 49 and 59 percent pineapple bran in the ration. Daily gains were reduced one-third and about 11 percent more feed was required to make a pound of gain with the ration containing 59 percent pineapple bran.

Trial III was really an experiment comparing wheat middlings with rice bran, but each ration contained 49 percent pineapple bran as well. About 11 percent more feed was required to make a pound of gain with the rice bran ration.

Trial IV compared a ration containing only 27 percent ground pineapple bran with a standard control ration. Gains were 12.5 percent greater on the control ration, but only 3.6 percent more feed was required to make a pound of gain on the pineapple bran ration.

TABLE 18. Percentage composition of control and experimental rations used in pineapple bran feeding trials I to XI.

TRIAL	RATION	BARLEY	TANKAGE	PINEAPPLE BRAN	GROUND PINEAPPLE BRAN	WHEAT MIDDLINGS	COCONUT OIL MEAL	RICE BRAN	SALT	ROCK PHOSPHATE	CANE MOLASSES	FISH MEAL	SOYBEAN OIL MEAL	BONEMEAL	LINSEED OIL MEAL
	Control J	90	10	..	..	..	..	..	..	..	..	..	..	..	..
I	Expt. 31	..	10	50	..	30	10	..	..	..	..	..	..	..	..
	Expt. 32	..	10	50	..	..	10	30	..	..	..	..	..	..	..
II	Expt. 33	..	10	49	..	29	10	..	1	1	..	..	..	..	..
	Expt. 34	..	10	59	..	19	10	..	1	1	..	..	..	..	..
III	Expt. 33	..	10	49	..	29	10	..	1	1	..	..	..	..	..
	Expt. 35	..	10	49	..	..	10	29	1	1	..	..	..	..	..
IV	Control D	64	..	..	..	..	..	..	1	..	20	7	7	1	..
	Expt. 36	34	..	..	27	..	..	..	1	..	20	8	9	1	..
	Control E	68	..	..	..	..	..	..	1	..	20	5	5	1	..
V and VI	Expt. 37	..	..	..	70.5	..	..	..	0.7	..	14.1	7.0	7.0	0.7	..
	Expt. 38	..	..	..	61.6	..	..	..	0.6	..	12.4	12.4	12.4	0.6	..
VII, VIII,	Control A	68	..	..	..	..	..	..	1	..	20	8	..	1	2
and IX	Expt. 39	14	..	50*	..	..	..	..	1	..	20	12	..	1	2
X	Control K	88	7	..	..	..	..	..	1	1	..	..	..	..	3
	Expt. 40	..	12	38	..	20	..	..	1	1	25	..	..	..	3
XI	Control D	64	..	..	..	..	..	..	1	..	20	7	7	1	..
	Expt. 41	34	..	..	27	..	..	..	1	..	20	8	9	1	..

* Coarse bran in trials VII and finely ground in trials VIII and IX.

TABLE 19. Results of pineapple bran feeding trials.

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	POUNDS CONCENTRATE FEED CONSUMED PER POUND OF GAIN	CONCENTRATE FEED COST PER POUND OF GAIN			
							1936	1940	1944	1948
			days	*pounds*	*pounds*					
I	Control J	5	85	79.6	1.34	4.02	$.0575	$.0679	$.1588	$.2432
	Experiment 31	5	85	79.8	1.08	4.24	.0628	.0619	.0890	.1433
	Experiment 32	5	85	80.0	0.91	4.52	.0588	.0588	.0881	.1338
II	Experiment 33	3	84	64.3	1.08	4.59	.0684	.0675	.0968	.1547
	Experiment 34	4	84	60.5	0.72	4.96	.0689	.0684	.0952	.1533
III	Experiment 33	4	126	46.5	0.98	4.19	.0624	.0616	.0884	.1412
	Experiment 35	5	126	48.5	0.66	4.65	.0609	.0609	.0911	.1381
IV	Control D	6	84	72.1	1.44	4.76	.0590	.0685	.1590	.2456
	Experiment 36	7	84	72.0	1.28	4.92	.0576	.0630	.1264	.1993
V	Control E	5	79	68.0	1.59	4.82	.0578	.0680	.1595	.2463
	Experiment 37	5	107	60.8	1.15	5.12	.0538	.0543	.0778	.1265
VI	Control E	7	43	120.0	1.60	4.80	.0576	.0677	.1589	.2453
	Experiment 38	7	43	120.0	1.63	5.22	.0626	.0637	.1002	.1603
VII*	Control A	3	76	69.8	1.58	4.02	.0486	.0567	.1347	.2066
	Experiment 39	3	76	71.1	0.81	5.54	.0598	.0620	.1091	.1717
VIII*	Control A	3	35	67.3	1.40	3.97	.0480	.0560	.1330	.2041
	Experiment 39	3	35	66.5	0.71	5.70	.0616	.0638	.1123	.1767
IX*	Control A	4	35	126.9	1.68	4.63	.0560	.0653	.1551	.2380
	Experiment 39	4	35	127.2	1.14	5.74	.0620	.0643	.1131	.1779
X	Control K	6	126	50.0	1.10	4.25	.0603	.0710	.1666	.2533
	Experiment 40	6	126	50.0	0.62	7.06	.0861	.0840	.1193	.2076
XI†	Control D	6	84	72.1	1.44	4.76	.0590	.0685	.1590	.2456
	Experiment 41	7	84	72.0	1.28	4.92	.0576	.0630	.1264	.1993

* By L. A. Henke and G. W. H. Goo.

† By S. H. Work and L. A. Henke.

Trial V compared gains of pigs weighing 60 to 70 pounds when fed the control and a 70.5 percent pineapple bran ration. Daily gains were about 30 percent higher on the control ration.

Trial VI was somewhat similar to trial V, but the experimental ration contained more protein supplements and this was fed to pigs having an initial weight of 120 pounds. While about 3.4 percent more feed was required to make a pound of gain when the pineapple bran ration was fed, daily gains were about the same on both rations.

Trials VII, VIII, and IX were comparisons between a control and a 50 percent pineapple bran ration. Coarse bran was fed in trial VII, finely ground bran in trials VIII and IX. Gains on the pineapple bran rations were poor with 60- to 70-pound pigs, but materially better with 127-pound pigs (trial IX). Grinding pineapple bran did not seem to improve the rate of gain or efficiency of feed utilization. The difference in feed utilization between the control and pineapple bran ration was less with the older pigs (trial IX).

Trial X comparing a control with a 38 percent pineapple bran ration fed to 50-pound pigs resulted in very low gains and poor feed utilization on the pineapple bran ration. These pigs were obviously too small at the start of the trial to use pineapple bran properly.

Trial XI comparing the control ration with a 27 percent pineapple bran ration fed to 72-pound pigs resulted in 12 percent greater gains on the control ration, but feed utilization was only 3.6 percent better on the control ration.

While there was some variation in the results of the different trials, they do show the possibility of using pineapple bran in swine rations if it is properly supplemented with protein feeds; materially better results follow if the pineapple bran is fed to pigs weighing around 100 pounds or better. Pineapple bran contains about 20 percent fiber, which is too high for pigs, but older pigs can utilize this byproduct to better advantage than pigs that have just been weaned.

RICE PADDY FOR SWINE

Some years ago the Animal Husbandry Department was requested to evaluate Hawaiian rice paddy as a swine feed. One trial was conducted. A control lot was not possible at the time, but weighted results of five other trials in which a control ration was used are included for comparisons.

The rations were the same except that 58 pounds of rough rice plus 10 pounds of soybean oil meal in the experimental ration replaced 68 pounds of barley in the control ration. Based on feed required to make a pound of gain, the experimental ration was only 88.4 percent as effective as the control, indicating a materially higher value for barley than the mixture of 58 pounds of rough rice supplemented with 10 pounds of soybean oil meal.

TABLE 20. Composition of control and experimental rations used in rice paddy feeding trial.*

INGREDIENT	CONTROL RATION B	EXPERIMENTAL RATION 42
	percent	*percent*
Barley	68	..
Medium-ground rough rice	..	58
Cane molasses	20	20
Fish meal	10	10
Soybean oil meal	..	10
Salt	1	1
Bonemeal	1	1

* Trial conducted by Akio Kubota (student) and S. H. Work.

TABLE 21. Results of rice paddy feeding trial.

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	POUNDS CONCENTRATE FEED REQUIRED PER POUND OF GAIN	CONCENTRATE FEED COST PER POUND OF GAIN			
							1936	1940	1944	1948
			days	*pounds*	*pounds*					
I	Control B*	21	..	76.3	1.55	4.18	$.0510	$.0594	$.1417	$.2169
	Experiment 42	5	70	84.5	1.44	4.73	.0941	.0974	.1599	.2616

* Weighted results of five trials—not conducted simultaneously.

COMPARISON OF PROTEIN SUPPLEMENTS

Tankage versus Fish Meal: Five experiments comparing tankage (imported) and fish meal (locally produced) were conducted. Analyses of these protein supplements used in the first three trials appear in table 24.

In general the rate of gain was slightly greater and concentrate feed consumption was slightly less when fish meal was used as the protein supplement. However, the results were not consistent in the five trials; hence definite conclusions as to the superiority of either tankage or fish meal are hardly justified. However, it appears that locally produced fish meal is at least equal to tankage.

TABLE 22. Composition of the control and experimental rations used in fish meal and tankage feeding trials I*, II†, III‡, IV§, and V§.

INGREDIENTS	EXPERIMENTAL RATION 43	EXPERIMENTAL RATION 44
	percent	*percent*
Rolled barley	68	68
Cane molasses	20	20
Tankage	10	..
Fish meal	..	10
Salt	1	1
Bonemeal	1	1

* Trial conducted by L. A. Henke and G. W. H. Goo.
† Trial conducted by L. A. Henke and Richard S. Suzui (Senior student).
‡ Trial conducted by L. A. Henke and Hiroshi Ooka (Senior student).
§ Trials conducted by S. H. Work.

Fish Meal vs. Roasted Soybeans vs. Soybean Oil Meal: At the time these experiments were conducted there was some interest in the possibility of growing soybeans locally, which was the reason for these trials.

In trial I the best gains resulted when roasted soybeans were used as the protein supplement and in both trials less concentrates were required to make a pound of gain with this supplement. However, the results of the two trials are not in complete agreement and more work needs to be done to justify drawing definite conclusions. Results are tabulated on page 25.

TABLE 23. Composition of the control and experimental rations used in soybean and fish meal feeding trials I and II.*

INGREDIENTS	CONTROL RATION B	EXPERIMENTAL RATION 45	EXPERIMENTAL RATION 46
	percent	*percent*	*percent*
Rolled barley	68	63	65
Cane molasses	20	20	20
Fish meal	10	..	..
Ground roasted soybeans	..	15	..
Soybean oil meal	..	..	13
Salt	1	1	1
Bonemeal	1	1	1

* By S. H. Work and L. A. Henke.

TABLE 24. Analyses of tankage and fish meal used in pig rations.

	Trial	Dry matter	Crude protein	Ether extract	N-free extract	Crude fiber	Ash
		percent	*percent*	*percent*	*percent*	*percent*	*percent*
Tankage	I	92.91	60.56	7.17	4.12	2.16	18.90
	II	90.61	60.91	5.50	4.93	2.37	16.90
	III	92.37	62.22	4.94	6.48	2.70	16.03
Fish meal	I	92.49	57.78	4.95	8.44	1.00	20.32
	II	92.69	58.03	5.70	6.78	1.43	20.75
	III	93.31	57.62	5.86	7.29	1.35	21.19

TABLE 25. Results of fish meal and tankage feeding trials.

Trial	Ration	Number of pigs	Length of trial	Average initial weight of pigs	Average daily gain	Pounds concentrate feed consumed per pound of gain	Concentrate feed cost per pound of gain			
							1936	1940	1944	1948
			days	*pounds*	*pounds*					
I	Ration 43	4	77	67.9	1.38	3.99	$.0491	$.0571	$.1273	$.2011
	Ration 44	4	77	69.0	1.53	3.67	.0448	.0521	.1244	.1905
II	Ration 43	4	63	73.3	1.49	4.25	.0523	.0608	.1356	.2142
	Ration 44	4	63	73.0	1.63	3.95	.0482	.0561	.1339	.2050
III*	Ration 43	3	91	65.9	1.16	4.66	.0573	.0666	.1487	.2349
	Ration 44	3	91	66.4	1.10	4.93	.0601	.0700	.1671	.2559
IV	Ration 43	7	68	95.4	1.36	4.17	.0513	.0596	.1330	.2102
	Ration 44	7	68	96.0	1.39	4.16	.0508	.0591	.1410	.2159
V	Ration 43	5	107	52.1	1.24	5.40	.0664	.0772	.1723	.2722
	Ration 44	5	107	50.6	1.17	5.12	.0625	.0727	.1736	.2657
Total and Average	Ration 43	23	81	70.9	1.33	4.49	.0552	.0642	.1432	.2263
	Ration 44	23	81	71.0	1.36	4.37	.0533	.0621	.1481	.2268

* These pigs were vaccinated against hog cholera 68 days after the trial was started. After this, rates of gain were unfavorable.

TABLE 26. Results of soybean and fish meal trials.

TRIAL	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	POUNDS CONCENTRATE FEED CONSUMED PER POUND OF GAIN	CONCENTRATE FEED COST PER POUND OF GAIN			
							1936	1940	1944	1948
			days	*pounds*	*pounds*					
	Control B	4	57	98.0	1.56	4.57	$.0558	$.0649	$.1549	$.2372
I*	Experiment 45 ...	4	57	88.5	1.78	4.15	.0780	.0888	.1565	.2162
	Experiment 46 ...	3	57	95.7	1.64	4.72	.0571	.0666	.1529	.2384
	Control B	6	89	74.6	1.24	5.15	.0628	.0731	.1746	.2673
II	Experiment 45 ...	6	89	74.8	1.24	4.47	.0840	.0957	.1685	.2329
	Experiment 46 ...	6	89	75.0	1.34	4.78	.0578	.0674	.1549	.2414
Total	Control B	10	72	86.3	1.40	4.86	.0593	.0690	.1648	.2522
and	Experiment 45 ...	10	72	81.6	1.51	4.31	.0810	.0922	.1625	.2246
Average	Experiment 46 ...	9	72	85.3	1.49	4.75	.0575	.0670	.1539	.2399

* Illness was experienced in some cases and may reduce validity of results.

CULL FRUITS FOR SWINE

There are occasions, especially in places with poor marketing facilities and far removed from population centers, when fruits become available faster than they can be consumed. Even if market facilities are good, most crops will have cull fruits which cannot be sold. These can generally be fed to swine and the purpose of the trials here reported was to evaluate such fruits in terms of pork produced.

PAPAYAS

TABLE 27. Composition of the control and experimental rations in papaya feeding trials I, II, III, and IV.

INGREDIENTS	CONTROL RATION C	EXPERIMENTAL RATION 47	EXPERIMENTAL RATION 48
	percent	*percent*	*percent*
Barley	88	...	..
Tankage	8	...	..
Linseed oil meal	2	...	..
Salt	1	...	..
Bonemeal	1	...	..
Papayas	..	33.3	25
Control ration C	..	66.7	75

One way of evaluating unusual feeds utilized to replace part of a control ration is to express their value in terms of a percentage of the control ration which they replace. Thus in trial I, 1.05 pounds of control ration C (4.88 − 3.83 = 1.05) were replaced by 1.91 pounds of papayas, or, the papayas were worth 55 percent as much as the control ration when used to replace one-third of the control ration.

In the same way calculations show that the corresponding percentage values of papayas in trials II, III, and IV were 8.0, 22.2, and 8.1, respectively. These are wide variations and not much reliance can be placed on such variable results, but pending more data a present estimate is that papayas are worth about 23 percent as much as the control rations used when constituting one-fourth to one-third of the ration.

BANANAS

Applying the same manner of evaluating bananas as described for papayas, the bananas were worth 58.3, 16.6, and 38.5 percent as much as the control rations in trials I, II, and III, respectively, at the levels at which they were fed—one-fourth to one-third of the ration. This average, 37.8 percent, is materially higher than that of papayas.

TABLE 28. Composition of the experimental rations used in banana feeding trials I, II, and III.

INGREDIENTS	EXPERIMENTAL RATION 49	EXPERIMENTAL RATION 50
	percent	*percent*
Bananas*	33.3	25
Control ration C	66.7	75

* Chinese bananas.

TABLE 29. Results of papaya feeding trials.

TRIAL No.	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT	AVERAGE DAILY GAIN	FEED CONSUMED PER POUND OF GAIN		CONCENTRATE FEED COST PER POUND OF GAIN			
						Concentrate	Papayas	1936	1940	1944	1948
			days	*pounds*	*pounds*	*pounds*	*pounds*				
I*	Control C	3	98	56.7	1.19	4.88	...	$.0698	$.0820	$.1918	$.2913
	Expt. 47	3	98	58.8	1.16	3.83	1.91	.0597	.0689	.1619	.2474
II†	Control C	5	105	53.3	1.22	4.41	...	.0631	.0741	.1733	.2633
	Expt. 47	5	105	59.4	1.12	4.24	2.12	.0661	.0763	.1794	.2741
III‡	Control C	6	84	72.1	1.44	4.76	...	.0681	.0800	.1871	.2842
	Expt. 47	7	84	74.3	1.35	4.30	2.07	.0662	.0764	.1796	.2745
Total and Average	Control C	14	96	60.7	1.28	4.68	...	.0669	.0786	.1839	.2794
	Expt. 47	15	96	62.5	1.21	4.12	2.03	.0640	.0738	.1734	.2651
IV*	Control C	4	92	65.7	1.25	4.58	...	.0655	.0769	.1800	.2734
	Expt. 48	4	92	65.2	1.28	4.46	1.48	.0671	.0784	.1841	.2810

* By L. A. Henke and G. W. H. Goo. † By L. A. Henke and Masao Koga (Senior student). ‡ By S. H. Work.

TABLE 30. Results of banana feeding trials.

TRIAL No.	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT	AVERAGE DAILY GAIN	FEED CONSUMED PER POUND OF GAIN		CONCENTRATE FEED COST PER POUND OF GAIN			
						Concentrate	Bananas	1936	1940	1944	1948
			days	*pounds*	*pounds*	*pounds*	*pounds*				
I*	Control C	3	98	56.7	1.19	4.88	...	$.0698	$.0820	$.1918	$.2913
	Expt. 49	3	98	58.7	1.19	3.70	1.85	.0605	.0694	.1637	.2486
II†	Control C	5	105	53.3	1.22	4.41	...	.0631	.0741	.1733	.2633
	Expt. 49	5	105	54.2	1.15	4.07	2.04	.0666	.0764	.1802	.2737
Total and Average	Control C	8	101	55.0	1.20	4.64	...	.0664	.0780	.1824	.2770
	Expt. 49	8	101	56.4	1.17	3.88	1.94	.0634	.0727	.1717	.2607
III*	Control C	4	113	66.5	1.02	5.18	...	.0741	.0870	.2036	.3092
	Expt. 50	4	113	66.6	1.15	4.59	1.53	.0716	.0832	.1958	.2968

* By L. A. Henke and G. W. H. Goo. † By L. A. Henke and Masao Koga (Senior student).

AVOCADOS

Applying the same method to evaluating avocados that was used for papayas and bananas, the avocados were worth 45.6 and 22.7 percent as much as the control rations which they replaced to the extent of 25 and 30 percent in trials I and II, respectively.

TABLE 31. Composition of the control and experimental rations used in avocado feeding trials I and II.

INGREDIENTS	TRIAL I	TRIAL II	
	Experimental ration 51	Control ration E	Experimental ration 52
	percent	*percent*	*percent*
Barley	..	68	...
Cane molasses	..	20	...
Fish meal	..	5	...
Soybean oil meal	..	5	...
Bonemeal	..	1	...
Salt	..	1	...
Avocados	25	..	30.5
Control ration C	75	..	...
Control ration E	..	..	69.5

TOMATOES

At times cull tomatoes are available and several trials have been conducted to determine their value in swine feeding. Several analyses of the fresh fruits as fed were made by the Chemistry Department and are tabulated in table 34.

In trial I, when feeding pigs having an initial weight of about 75 pounds, tomatoes had a value of 11.7 percent of the control ration when constituting 70 percent of the ration, 5.6 percent when constituting 84 percent of the ration, and no value at all when constituting 100 percent of the ration.

In trial II with pigs having an average initial weight of 117 pounds, tomatoes had a value of 11.7 percent of the control ration when constituting 85.6 percent of the ration, 10.4 percent when constituting 92.6 percent of the ration, and 4.4 percent when constituting 98.4 percent of the ration.

All these fruit studies are based on very limited work and cannot be considered conclusive; pending more work they serve as a rough guide of what may be expected when feeding excess or cull fruits to swine.

TABLE 32. Results of avocado feeding trials.

Trial No.	Ration	Number of pigs	Length of trial	Average initial weight	Average daily gain	Feed consumed per pound of gain		Concentrate feed cost per pound of gain			
						Concentrate	Avocados	1936	1940	1944	1948
			days	*pounds*	*pounds*	*pounds*	*pounds*				
I*	Control C	3	42	122.9	1.64	5.45	...	$.0779	$.0916	$.2142	$.3254
	Expt. 51 .	3	42	123.2	1.62	4.73	1.58	.0738	.0858	.2019	.3060
II†	Control E	5	78	99.9	1.33	5.74	...	.0689	.0809	.1900	.2933
	Expt. 52 .	5	78	100.6	1.33	5.22	2.29	.0841	.0969	.2283	.3462

* By L. A. Henke and G. W. H. Goo. † By S. H. Work.

TABLE 33. Composition of the control and experimental rations used in tomato feeding trials I and II.

*Trial I**

Ingredients	Control ration D	Experimental ration 53	Experimental ration 54	Experimental ration 55
	percent	*percent*	*percent*	*percent*
Barley	64	..	...	...
Cane molasses	20	..	...	...
Fish meal	7	..	...	...
Soybean oil meal	7	..	...	...
Salt	1	..	...	...
Bonemeal	1	..	...	...
Tomatoes	..	70	84.1	100
Control ration D	..	30	15.9	...

*Trial II**

Ingredients	Experimental ration 56	Experimental ration 57	Experimental ration 58†
	percent	*percent*	*percent*
Tomatoes	85.6	92.6	98.4
Control ration D	14.4	7.4	1.6

* By S. H. Work. In trial I the supply of tomatoes ran out after 22 days. The trial was resumed again as trial II when tomatoes again became available.

† This ration was supposed to be all tomatoes, but on a few days when tomatoes were not available some concentrates were fed.

TABLE 34. Analyses of cull tomatoes used in pig rations.

DATE	NUMBER SAMPLES IN COMPOSITE	PERCENTAGE ON FRESH BASIS						
		Moisture	Protein	Fat	Fiber	N-free matter	Ash	Total nutrients
Dec. 1940	5	95.76	1.20	0.20	0.52	1.78	0.54	...
Feb. 1941	5	93.86	1.25	0.28	0.68	3.22	0.71	...
Mar. 1941	6	93.63	1.25	0.19	0.99	3.27	0.67	...
Average		94.42	1.23	0.22	0.73	2.76	0.64	5.21

TABLE 35. Results of tomato feeding trials.

TRIAL NO.	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT	AVERAGE DAILY GAIN	FEED CONSUMED PER POUND OF GAIN		CONCENTRATE FEED COST PER POUND OF GAIN			
						Concentrate	Tomatoes	1936	1940	1944	1948
			days	*pounds*	*pounds*	*pounds*	*pounds*				
I	Control D	8	22	73.6	1.20	4.10	....	$.0508	$.0590	$.1369	$.2116
	Expt. 53	8	22	75.0	1.13	3.22	7.49	.0514	.0578	.1264	.2110
	Expt. 54	8	22	75.9	0.75	3.16	16.71	.0636	.0695	.1470	.2623
	Expt. 55	8	22	74.0	0	...	22.05*		No gains made		
II	Control D	4	45	112.7	1.77	4.36	...	.0541	.0628	.1456	.2250
	Expt. 56	4	45	124.2	1.81	2.57	15.3	.0554	.0608	.1233	.2252
	Expt. 57	4	45	119.2	1.42	1.89	23.79	.0591	.0642	.1233	.2414
	Expt. 58	5	52	111.4	0.66	1.15	72.30	.1249	.1249	.2203	.4921

* Consumed per pig per day.

GARBAGE FEEDING

The swine industry of Hawaii is based on garbage feeding and the size of the industry tends to be directly proportional to the available supply of garbage. During the war years garbage supplies were plentiful and the number of hogs in Hawaii was roughly double the prewar and postwar totals.

Many experiments on the value of military garbage as a hog feed were conducted at this station and the results of these trials are fully described in another publication.[4] For completeness and because of the importance of garbage feeding in Hawaii, a very brief summary of the results of these trials is given.

MILITARY GARBAGE AS A FEED FOR GROWING AND FATTENING PIGS

Uncooked Garbage Supplemented with Concentrates: A series of five trials was conducted in which control ration L was compared with a limited amount of control ration L supplemented by garbage.[5]

TABLE 36. Composition of the control and experimental rations used in garbage feeding trials I–V.

Control ration L

	percent
Barley	64
Cane molasses	20
Tankage	7
Soybean oil meal	7
Steamed bonemeal	1
Salt	1

INGREDIENT	EXPERIMENTAL RATION 59	EXPERIMENTAL RATION 60	EXPERIMENTAL RATION 61	EXPERIMENTAL RATION 62	EXPERIMENTAL RATION 63
	percent	*percent*	*percent*	*percent*	*percent*
Control ration L...	16.9	12.3	18.5	21.6	17.8
Uncooked garbage..	83.1	87.7	81.5	78.4	82.2

Cooked vs. Uncooked Garbage: Three trials comparing cooked and uncooked garbage were conducted using the same concentrate ration L as was used in trials I, II, III, IV, and V above. These were designated trials VI, VII, and VIII.

Value of Molasses Added to Garbage: As the supply of garbage was reduced at the end of the war, trials were conducted to determine whether the supply could be augmented by the addition of cane molasses. One trial (IX) in which 0, 10, 20, and 30 percent molasses were added to uncooked garbage was conducted. Results are given in table 39.

[4] WILLETT, E. L., HENKE, L. A., WORK, S. H., MARUYAMA, C., and ROSS, WINIFRED. GARBAGE AS A FEED FOR SWINE. Hawaii Agr. Expt. Sta. Tech. Bul. 7, pp. 1–40. 1948.

[5] Trials conducted by L. A. Henke, E. L. Willett, S. H. Work, and C. Maruyama.

TABLE 37. Composition of rations used in garbage trials VI–VIII.

INGREDIENT	TRIAL VI		TRIALS VII AND VIII	
	Experimental ration 64	Experimental ration 65	Experimental ration 66	Experimental ration 67
	percent	*percent*	*percent*	*percent*
Control ration L.....	7	5.8	...	...
Cooked garbage	93	..	100	...
Uncooked garbage	..	94.2	...	100

TABLE 38. Composition of rations in garbage and molasses trial IX.

INGREDIENT	EXPERIMENTAL RATION 67	EXPERIMENTAL RATION 68	EXPERIMENTAL RATION 69	EXPERIMENTAL RATION 70
	percent	*percent*	*percent*	*percent*
Cane molasses	...	10	20	30
Uncooked garbage	100	90	80	70

Military garbage fed in these trials had a value approximately 40 percent that of a good grain ration based on the quantity required to produce a pound of gain. Garbage alone proved to be an excellent feed for fattening hogs and if of as good quality as was available during the war years, 9 to 13 pounds of garbage should produce about 1 pound liveweight gain in pigs.

Cooking garbage did not lower the feeding value of military garbage significantly. Regulations of the Board of Health of the Territory of Hawaii require the cooking of all garbage fed to swine.

Addition of cane molasses to garbage materially increased the amount of the mixture required to make a pound of gain. The difference was small when only 10 percent molasses was added but rather marked when molasses was increased to 30 percent. This may in part have been due to insufficient protein as the percentage of molasses was increased, and perhaps if additional protein had been added the differences in feed requirements would not have been so great.

GARBAGE AS A FEED FOR WEANLING PIGS

Four trials in which garbage and a mixture of garbage and cane molasses were compared with concentrate control mixtures as a feed for pigs from weaning to about the 70-pound weight were conducted. In general, good gains were secured when garbage and supplementary green feed were fed. Pigs receiving garbage and molasses made inferior gains. Garbage containing large amounts of leafy vegetables or fat was less satisfactory.

GARBAGE FOR BROOD SOWS

Garbage was compared with concentrate rations and combinations of garbage and concentrate rations. Under the condition of these experiments no significant differences in size of litters, average birthweight of pigs, or mortality could be demonstrated between the different methods of feeding. Milk of garbage-fed sows was higher in fat content, but no detrimental effects upon the nursing pigs was observed.

TABLE 39. Results of garbage feeding trials.

TRIAL NO.	RATION	NUMBER OF PIGS	LENGTH OF TRIAL	AVERAGE INITIAL WEIGHT OF PIGS	AVERAGE DAILY GAIN	FEED CONSUMED PER POUND OF GAIN		CONCENTRATE FEED COST PER POUND OF GAIN			
						Concentrate mixture	Garbage	1936	1940	1944	1948
			days	*pounds*	*pounds*	*pounds*	*pounds*				
I	Control L	3	49	132.2	1.19	5.94	...	$.074	$.085	$.190	$.301
	Expt. 59	3	49	132.5	1.50	1.99	9.81	.074	.078	.103	.297
II	Control L	4	86	87.6	1.36	5.09	...	.064	.073	.163	.258
	Expt. 60	4	86	87.4	1.45	1.52	10.79	.073	.076	.092	.293
III	Control L	4	71	91.1	1.15	5.80	...	.072	.083	.186	.293
	Expt. 61	3	71	94.1	1.75	1.88	8.28	.064	.068	.093	.261
IV	Control L	3	111	73.9	1.13	6.28	...	.078	.090	.201	.318
	Expt. 62	3	111	81.0	1.16	2.51	9.68	.079	.084	.119	.321
V	Control L	4	63	79.9	1.05	4.36	...	.054	.063	.139	.221
	Expt. 63	4	63	79.4	1.52	1.51	6.99	.054	.057	.076	.216
VI	Expt. 64	4	86	111.2	1.22	0.66	8.73	.052	.053	.056	.208
	Expt. 65	4	86	110.5	1.29	0.50	8.06	.046	.047	.048	.186
VII	Control L	5	105	75.2	1.24	6.98	...	.087	.100	.223	.353
	Expt. 66	5	105	73.8	1.40	...	8.71	.044	.044	.035	.174
	Expt. 67	5	105	78.1	1.50	...	8.12	.041	.041	.032	.162
VIII	Expt. 66	3	77	72.0	1.46	...	9.31	.047	.047	.037	.186
	Expt. 67	3	77	71.5	1.44	...	9.33	.047	.047	.037	.187
IX	Expt. 67	7	154	44.8	1.19	...	13.00	.065	.065	.052	.260
	Expt. 68	7	154	41.3	1.06	1.32*	11.88	.062	.062	.051	.254
	Expt. 69	7	154	42.1	0.94	2.92*	11.68	.065	.065	.056	.270
	Expt. 70	7	154	42.5	0.82	4.89*	11.41	.069	.069	.061	.289

* Cane molasses.

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